

From the Surgical Department of the Bürgerspital Basel, Switzerland  
Director: Prof. H. Heusser

**The Experimental Effect of Sorbacel Gauze Surgically  
Introduced into Bladders and Prostates of Rats**

Inaugural Dissertation

to acquire the doctorate degree of the Medical Faculty of the  
University of Basel, Switzerland

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JOSEPH MENDELOW

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### *Introduction*

Sorbacel is a resorbable gauze product of Dr. A. Wander A.G., Berne, Switzerland, produced by the oxydation of cotton gauze followed by neutralization of the resulting polyuronic acids with calcium. Ninety-eight per cent of the material is neutralized by the calcium, the remaining 2% polyuronic acids give the gauze a pH of 4.5 to 5.5.

In order to distinguish Sorbacel from ordinary gauze which it outwardly resembles in every manner, it is dyed blue. The gauze is sensitive to light, heat and atmospheric oxygen.

The hemostatic effect of Sorbacel is due to its extensive wettable surface, compression action as a tampon and to a degree to the presence of some 6% calcium.

Dissolution occurs by hydrolytic fission of the fiber molecule into soluble particles capable of diffusing into tissue and being excreted with urine.

Sorbacel finds its use in both major and minor surgery. This paper is concerned primarily with the use of Sorbacel in urology where it is in use as a tampon following prostatectomy.

### *Problem*

1. The tendency of calculi to form the introduction of Sorbacel into prostates of rats.
2. The tendency of calculi to form following the introduction of Sorbacel into bladders of rats.
3. The most favorable urine pH and specific gravity to dissolve Sorbacel.

### *Methods*

The methods used in the experiments were those modified from the procedure used by *C. W. Vermeulen* M.D. in a paper on Experimental Urolithiasis (*The Journal of Urology*, vol. 64, no. 4, Oct. 1950) from the Department of Surgery, University of Illinois, College of Medicine, Chicago, U.S.A.

1. Young adult male rats weighing 150-200 grams.
2. Ether anesthesia.
3. Aseptic technique involving only Desogen antiseptic.
4. Sorbacel (about the size of a whole pepper kernel) introduction through a suprapubic incision.
5. A single stitch of 4-0 catgut to close bladder or prostate.
6. Feeding animals a known stock diet: both food and water available at all times.
7. After 1-47 days: sacrifice of animals and removal of both bladder and prostate.
8. Microscopic and macroscopic examination of fixed (in 5% formaldehyde) material.

9. *In vitro* testing of solubility in urines ranging from pH 4.8 to 8.1 and specific gravities from 1010 to 1028 after 24, 48 and 72 hours at room temperature (20° to 25° C.).

The experiment was done in two separate series of prostate and bladder each. Twenty adult male rats weighing 150–250 grams were used in each series. All operations were done under ether anesthesia. The instruments were cleansed with Desogen solution: sterile gloves and suture used. In each case the abdomen was clipped and cleansed with tincture of desogen followed by alcohol. Through a 3 cm. longitudinal suprapubic incision, the Sorbacel was introduced either into the bladder or prostate.

In the prostate series one lobe was transversely cut, Sorbacel introduced and then sutured with a single stitch of 4-0 catgut. Similarly in the bladder series, the apex of the bladder was cut, Sorbacel introduced and closed with a single stitch of 4-0 catgut. In all cases the Sorbacel introduced was about the size of a whole white pepper kernel. The abdominal incision was closed by muscle sutures followed by cutaneous, both with catgut. Careful cleansing of the wound was done with alcohol and then sprayed with a protective sterile waterproof film. The operative mortality was less than 3%. Each animal was provided with a marked separate cage having both food and water available at all times. All the animals were fed the customary stock diet.

After 1–47 days, the animals were sacrificed and both prostate and bladder removed. Five-per cent formaldehyde was used to fix the material which was examined histologically and macroscopically.

Human urine from the surgical laboratory was used for testing solubility. PH determination was done with indicator paper and specific gravity in the usual clinical manner. One square cm. of 3 layer thickness Sorbacel was placed in approximately 20 cc. of urine of pH 4.8–8.1 and specific gravity 1010–1028. The test tubes were kept at room temperature in series of 24, 48 and 72 hours.

### *Results*

1. The tendency of calculi to form following the introduction of Sorbacel into the prostates of rats.

- a) The macroscopic examination:

Each rat having been assigned a number was sacrificed after 1 to 19 days. Both the prostate and bladder were removed, fixed and examined macroscopically. In no case was there macroscopic evidence of a residue in the prostate. All the findings were confined to the bladder which after 24 hours in one case (no. 5) was filled with an amorphous white mass representing dissolved Sorbacel that had diffused from the prostate.

All the findings could be classified:

1. bladder filled with amorphous white mass,
2. bladder filled with fibrous white mass,
3. empty bladder.

In the case of the fibrous white mass, tiny fibrous particals barely visible to the naked eye could be identified by careful examination. At no time were calculi found. Table 1 shows the findings listed according to days following the introduction of the gauze tampon.



Table 1  
The Macroscopic Examination of Prostates

| Post Op.<br>Day | Rat nos.           | Finding                                                                                                                                                                  |
|-----------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1               | 5<br>7             | bladder filled with amorphous white mass<br>empty bladder                                                                                                                |
| 2<br>4          | 3<br>4             | bladder filled with amorphous white mass<br>bladder filled with fibrous white mass                                                                                       |
| 9               | 18<br>19           | bladder filled with amorphous white mass<br>bladder filled with amorphous white mass                                                                                     |
| 14              | 13<br>15           | bladder filled with fibrous white mass<br>bladder filled with amorphous white mass                                                                                       |
| 19              | 8<br>9<br>10<br>11 | bladder filled with fibrous white mass<br>bladder filled with amorphous white mass<br>bladder filled with fibrous white mass<br>bladder filled with amorphous white mass |

b) The microscopic examination:

Again fixed material was used for the histology (Dr. *M. Aufdermaur*, Institute of Pathology, Kantonsspital, Luzern, Switzerland). In no case could calculi be histologically demonstrated.

Here the findings could be classified:

1. foreign body reaction (granuloma formation), see ill. 1,
2. solid fibrous mass formation in the bladder.

Table 2 lists the histological findings of Sorbacel introduced into the prostate.

2. The tendency of calculi to form following the introduction of Sorbacel into the bladders of rats.

a) The macroscopic examination:

Each rat having been assigned a letter of the alphabet was sacrificed after 6 through 28 days and the fixed material examined macroscopically. The findings could be classified:

1. bladder filled with amorphous white mass,
2. bladder filled with fibrous white mass,
3. bladder filled with solid rubbery mass,
4. empty bladder.

At no time were calculi found. Table 3 lists the macroscopic findings.

Table 2  
Microscopic Examination of Prostates

| Post Op.<br>Day | Rat<br>Nos. | Finding                                                                                                                                                                                                                                                                                                                  |
|-----------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9               | 16          | many eosinophilic leucocytes as well as few lymphocytes and plasma cells in the bladder wall.                                                                                                                                                                                                                            |
|                 | 17          | bladder with amorphous mass. Bladder wall with few neutrophilic and eosinophilic leucocytes. Prostate with few neutrophilic and eosinophilic leucocytes. Granuloma (see ill. 1) with foreign body giant cells surrounding strong refractive foreign body. Granuloma in turn, surrounded by many eosinophilic leucocytes. |
| 14              | 12          | in the bladder and prostate are fibrous formations: those in the prostate are surrounded by leucocytes. A connective tissue capsule rich in fibrocytes encloses this bank of leucocytes. The bladder wall contains eosinophilic leucocytes.                                                                              |
|                 | 14          | amorphous mass in the bladder. Bladder wall with few eosinophilic leucocytes. Granuloma (see ill. 1) in the prostate contains multinuclear foreign body giant cells. Prostate with few neutrophiles and eosinophiles. Granuloma contains refractive foreign body surrounded by giant cells and eosinophiles.             |
| 18              | 6           | few eosinophiles in the bladder wall. Prostate with foci containing eosinophiles and plasma cells. Within the prostate are multinuclear giant cells of the foreign body type surrounding longitudinal gaps in the tissue.                                                                                                |
| 47              | 1           | bladder contains erythrocytes and fibrous constituents. Very few leucocytes in the bladder wall.                                                                                                                                                                                                                         |
|                 | 2           | fibrous mass in the bladder wall. Bladder wall with few eosinophiles.                                                                                                                                                                                                                                                    |

b) The microscopic examination:

As in the case of the prostate, the histological findings could be classified:

1. foreign body reaction (granuloma formation), see ill. 1,
2. solid fibrous mass formation in the bladder.

Included in this examination are two control animals (I and II) sacrificed after 17 days. The control animals were similarly operated, but no gauze tampon was introduced. Technique of operation, sterility and suture were identical. Table 4 lists the histological findings including the two control animals.



Table 3  
The Macroscopic Examination of Bladders

| Post Op.<br>Day | Rat<br>Letter | Finding                                                                        |
|-----------------|---------------|--------------------------------------------------------------------------------|
| 6               | A             | bladder filled with amorphous white mass                                       |
|                 | B             | bladder filled with amorphous white mass                                       |
| 9               | E             | bladder filled with material of rubbery consistency having a nucleus of fibers |
|                 | F             | bladder filled with amorphous white mass                                       |
| 10              | Q             | bladder filled with fibrous white mass                                         |
| 21              | K             | bladder filled with amorphous white mass                                       |
|                 | M             | bladder empty                                                                  |
|                 | N             | bladder filled with amorphous white mass                                       |
| 26              | I             | bladder empty                                                                  |
|                 | J             | bladder filled with amorphous white mass                                       |
| 28              | S             | bladder filled with fibrous white mass                                         |
|                 | T             | bladder filled with fibrous white mass                                         |



Ill. 1. Foreign body granuloma of the prostate (1:130).

Table 4  
The Microscopic Examination of Bladders

| Post Op.<br>Day | Rat<br>Letter | Finding                                                                                                                                                                                                                                                          |
|-----------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10              | O             | fibrous formations surrounded by banks of leucocytes along the bladder wall and included in a connective tissue capsule rich in fibrocytes. The surrounding tissue is edematous and infiltrated with eosinophiles and fewer neutrophils as well as plasma cells. |
|                 | P             | no abnormal findings                                                                                                                                                                                                                                             |
| 17              | I<br>II       | foci containing eosinophiles in the bladder wall. No abnormal finding in the prostate.                                                                                                                                                                           |
| 21              | L             | Bladder wall with few eosinophiles. Circumscribed groups of round cells in the perivesicular fat.                                                                                                                                                                |
| 26              | H             | bladder wall with few eosinophiles.                                                                                                                                                                                                                              |
| 28              | R             | perivascular groups of eosinophiles. No abnormal findings in the bladder or prostate.                                                                                                                                                                            |
| 33              | C             | few eosinophiles in bladder wall, prostate shows no abnormal findings, no granuloma.                                                                                                                                                                             |
|                 | D             | few eosinophiles in bladder wall. Thin granulation tissue containing lymphocytes, plasma cells and few eosinophiles, lying between the muscle layer and mucous membrane.                                                                                         |
|                 | G             | no abnormal findings.                                                                                                                                                                                                                                            |

3. The most favorable urine pH and specific gravity to dissolve Sorbacel.

All readings were done on the basis of minimum to maximum, graded as: minimum, 1 plus, 2 plus, 3 plus, 4 plus, 4 plus being the maximum.

Minimal solubility: The Sorbacel retained its form and color.

1 plus: appeared as a gelatinous blue mass.

2 plus: appeared as a fibrous white mass.

3 plus: appeared as an amorphous white mass.

4 plus: showed complete disintegration.

It should be noted that a gradation from minimum to maximum solubility was found showing intermediary solubility: for example, amorphous white mass and partial disintegration. In each case the specific gravity was recorded along with the pH. The experiment was done in three series of 24, 48 and 72 hours each (fig. 1, 2 and 3). Fig. 1, 2 and 3 list the solubility in terms of pH whereas fig. 4 lists the solubility according to specific gravity.

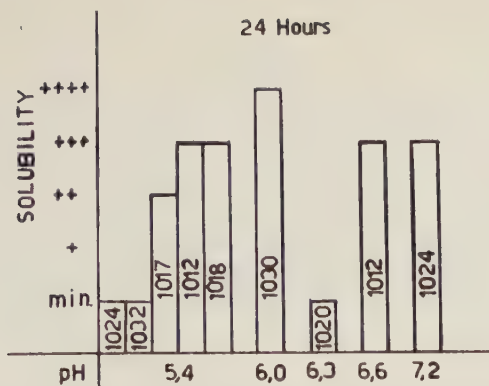


Fig. 1. Sorbacel solubility after 24 hours. Each column is designated with the specific gravity value.

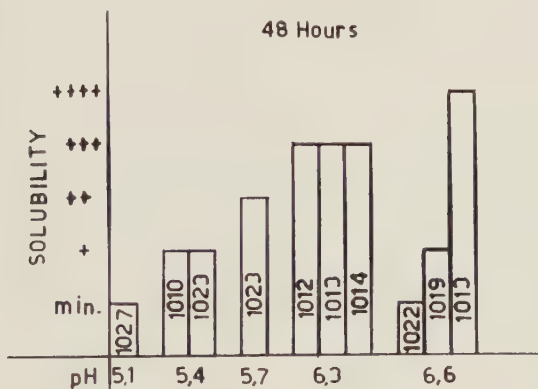


Fig. 2. Sorbacel solubility after 48 hours. Each column is designated with the specific gravity value.

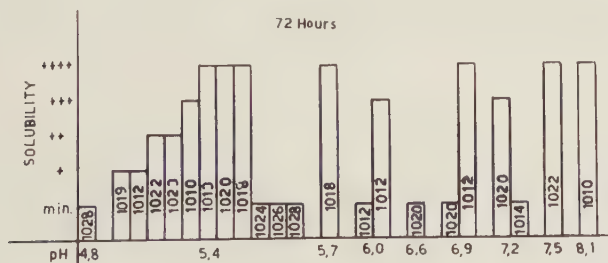


Fig. 3. Sorbacel solubility after 72 hours. Each column is designated with the specific gravity value.



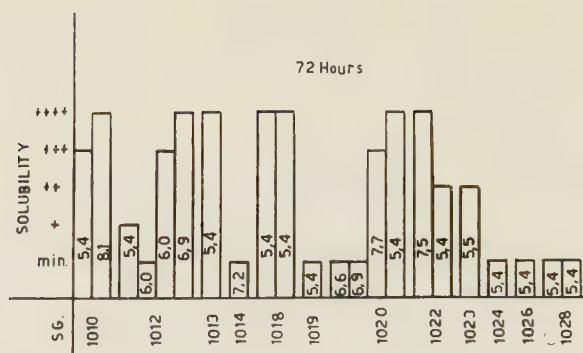


Fig. 4. Sorbacel solubility after 72 hours. Each column is designated with the pH value.

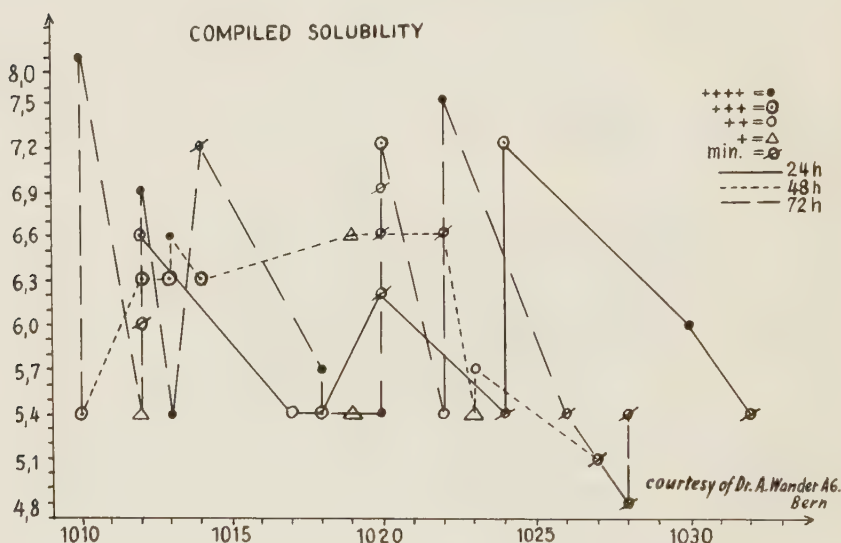


Fig. 5. Compiled solubility according to specific gravity and pH at 24, 48 and 72 hours.

### Discussion

The incision having been made along the external lateral border of the prostate did not permit direct communication of the tampon imbedded in the glandular tissue with the urine of the bladder. Therefore, the diffusable property of Sorbacel was adequately demonstrated, where 24 hours following the introduction into the prostate: it appeared in one case in the bladder as an amorphous white mass and in another had obviously been excreted

with the urine. However, it is possible that the tampon had been extruded into the bladder either as a whole or partially, in the sense of a foreign body. Due to the comparative narrowness of the rat's urethra, particles of Sorbacel would be retained in the bladder until further dissolution by urine action.

In three cases a mass of rubbery consistency was found in the bladder. The histology showed the mass to have a nucleus of fibrous material surrounded by leucocytes and enclosed in a connective tissue capsule rich in fibrocytes. It would be mere speculation on the basis of this paper to say that this encapsulated mass could represent the ground structure for calculous formation. However, it is well known that a foreign body in the bladder can produce a calculus. Nevertheless, no calculi or structures of calculous nature could be demonstrated.

The tissue reaction was of the foreign body type, showing some tendency to form granuloma containing multinuclear giant cells. Furthermore, the inflammation was characterized by the predominance of eosinophilic leucocytes and plasma cells. There was no indication of an acute or chronic suppurative process nor of extended necrosis involving neighboring tissues or organs.

Fig. 5 shows the compiled study of factors of time, pH and specific gravity (courtesy of Dr. A. Wander A.G., Berne). Concentrations below specific gravity 1020 show a more frequent and complete dissolution, the higher concentrations a more frequent decrease in solubility. Although there is no correlation between solubility and pH at concentrations below 1020, the majority of negative results lie in the higher specific gravities at lower pH with good solubility at alkaline pH in the few cited cases.

Further work done by the Research Laboratory of Dr. A. Wander A.G. in Freiburg have shed more light on factors influencing the solubility. The experiments were done *in vitro* using Sorbacel squares of 4×4 cm. and in some cases 10×10 cm. in 50 to 100 cc. of urine from prostatectomized patients. The urine specific gravity varied between 1020 and 1030, most being between 1025 and 1030. These experiments were carried out at a temperature of 34–37° C. The results showed a correlation of pH and solubility: at pH 7.8–8.5 complete dissolution in 1–2 days, at pH 6.5–7.5 in 1–3 days and at pH 4.5–6.2 in 4–8 days. There was no diminuation in the solubility at higher concentrations.

It is apparent that the factor of temperature is important; body temperature being more favorable than room temperature (20–25° C.). Also the fact that the Wander experiments were observed for a longer period would explain the diminished solubility at higher concentrations and pH shown in the results of this paper: after a 3-day period the Wander results at these values are also negative. Since the Wander experiments did not include urine of lower concentration (below 1020) no further correlations could be established.

### *Summary*

Sorbacel is a resorbable oxydized cotton gauze capable of diffusing through prostate tissue to be excreted with the urine. It finds important application as tampon material following prostatectomy. Tissue reaction to the gauze is mild, showing some tendency to form granuloma. There is good solubility (*in vitro*) in urine of pH 5.4–7.5 and specific gravity 1017–24 at room temperature.





